

AMERICAN MUSEUM NOVITATES

Number 532

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

June 2, 1932

59. 79 S

THE VALIDITY OF *SIREN INTERMEDIA* LECONTE, WITH OBSERVATIONS ON ITS LIFE HISTORY

BY G. K. NOBLE AND B. C. MARSHALL

While recently studying the development of *Siren* with material received from Florida and Arkansas we have found that there are two forms confused under the name *Siren lacertina* Linné. These forms differ from one another in the size of the egg-capsules, the coloration of the young, the size at sexual maturity, and the average number of costal grooves. Since the two species occur together throughout most of their ranges we consider that they represent distinct species and not races. The case is comparable to that exhibited by certain southern species of *Desmognathus*, but differs in that the adults of the small species are much more difficult to distinguish from the immatures of the large one. The evidence for the validity of the small species will, therefore, be considered in detail.

First the question arises as to what name to apply to the small species. In 1826 LeConte described *Siren intermedia*, distinguishing it from *S. lacertina* only by its smaller size and reduced gills. It is now known that the latter character is of no value, since *S. lacertina* immersed in irritating fluids undergoes the same regression of the gills (Noble, 1924). LeConte made use of none of the diagnostic characters of our small species in defining *S. intermedia*. He did state that the greatest length of his species was twelve inches but added that he had not seen an "oviferous female." Since LeConte did not designate a type specimen, it is impossible to determine whether he was describing the adults of the small species of *Siren* which we are defining or whether his description was based solely on the young of the large species. Linnæus apparently gave the name *lacertina* to the large species, for in an early description (1767) he states that the species measures a foot and a half in length. Moreover, Ellis (1766), who supplied Linnæus with his specimens, has figured a *Siren* that agrees with the large species in size. We have not been able to locate any of the material that LeConte had before him when he drew up his description of *intermedia*. Even if a specimen should be found and its specific status determined, this will not exclude the possibility that LeConte had other material at hand, possibly the

other species as well, when the description was written. Under these circumstances it seems most advisable for us to define the two species of *Siren* and to restrict LeConte's name *intermedia* to our small species.

Siren intermedia LeConte

Siren intermedia LECONTE, 1826, Ann. Lyc. Nat. Hist., New York, II, pp. 133-134, Pl. I. J. A. SMITH, *op. cit.*, pp. 261-263. HOLBROOK, 1842, 'N. A. Herp.,' V, p. 107, Pl. xxxv.

Siren lacertina COPE (not of Linné), 1889, 'Batr. N. Amer.,' Bull. U. S. N. M., No. 34, p. 226 (part).

DIAGNOSIS.—A dwarf species, the females reaching sexual maturity when only 195 to 272 millimeters in total length, costal grooves ranging from 31 to 35 in number, rarely reaching 36, while in *lacertina* they range from 36 to 39 in number but are usually either 37 or 38; egg with the same number of capsules as *lacertina* but the outer capsule much narrower; immature specimens with a broader head than the



Fig. 1.—Eggs of *Siren intermedia* LeConte, preserved in formalin a few days before hatching.

The opaque outer capsule is characteristic of the eggs of the Sirenidae.

immature *lacertina* and differently colored; the yellow band across the tip of the snout much broader than in *lacertina*; another yellow bar across the occiput; a narrow longitudinal stripe of yellow on the upper surface of the head mesial to each eye; older individuals uniform gray or with some indication of a pale streak on lips or side of body.

RANGE.—Southern United States and northern Mexico, as far north as Arkansas and Illinois in the west and Virginia in the east.

DISCUSSION OF SPECIFIC STATUS

Cope (1889, p. 228) in his description of *lacertina* states:

The transverse grooves are distinct on the sides and nearly meet on the belly, but are not distinct on the back. They vary from thirty-one to thirty-seven in

number. The larger specimens generally have thirty-six and thirty-seven grooves, while smaller ones frequently have only thirty-one and thirty-two. The specimens with thirty-three, thirty-four and thirty-five are of medium size; but a full-sized one from Georgia (No. 4535) has thirty-two, and a small one from South Carolina (No. 10514) has thirty-four. It was on specimens presenting the characters of the smaller individuals above mentioned that the *S. intermedia* of LeConte was proposed. I can not distinguish it from the ordinary form.

LeConte in his original description makes no mention of costal grooves and he indicates only a few in his figure of *S. intermedia*. However, he does emphasize the small size of the species. We have been able to compare a series of very young *Siren* collected at Gainesville, Florida, with a series hatched from eggs collected near Imboden, Arkansas. So far as we have been able to determine, only the large form of *Siren* occurs in the former locality and only the smaller in the latter. In a series (A. M. N. H. Nos. 32135-32149) of sixteen young from Gainesville, measuring only 31 to 53 mm. in total length and averaging 40.4 mm., we find one with thirty-six costal grooves, eleven with thirty-seven, three with thirty-eight, and one with thirty-nine. In contrast to this series the Imboden specimens, although measuring approximately the same length (35 to 57 mm. total length; 36.8 mm. in average), have a consistently lower number of costal grooves. There are two with thirty-four costal grooves and twelve with thirty-five. Moreover, we have counted the costal grooves in a large series of adults from both localities and have failed to find evidence of an increase in the number of costal grooves with advancing age.

Convincing evidence that Cope had before him two species, when describing *lacertina*, is to be found in the fact that several of the small specimens he mentions are sexually mature females with large pigmented eggs in the ovaries. For example, U.S.N.M. No. 4535, mentioned above, includes no less than five females with pigmented eggs in the ovaries measuring 2 to 2.5 mm. in diameter. These five specimens agree in having only thirty-two costal grooves. They differ only slightly in size. Their length from snout to anterior corner of cloaca, followed by their total length, is as follows: 142-237; 145-225; 137-210; 139-220; 122-237 mm. These specimens come from Riceboro, Georgia. In the collections of the American Museum there is a female from Valdosta, Georgia, having eggs from 2.5 to 3 mm. in diameter in the oviducts. This specimen has thirty-three costal grooves and is only 128 mm. from snout to cloaca and 195 mm. in total length. It is clear that in Georgia some sirens breed at a small size and these have a low number of costal grooves. In striking contrast a series of breeding females from Gaines-

ville, Florida, ranges from 450 to 500 mm. from snout to cloaca, and is proportionately much greater in girth than are the Georgia specimens. Such a marked difference in size in breeding females seems definite evidence that the Riceboro and Gainesville specimens represent distinct species.

Cope (1889) had before him both our large and small forms of *Siren* collected at the same locality. In the large series of *Siren* in the United States National Museum collected at Oakley, South Carolina, there are breeding females of both forms present, as the following table shows:

Siren lacertina from Oakley, S. C.

U.S.N.M.	Size of Ovarian Eggs	Snout to Ant. Corner of Cloaca	Total Length	No. of Costal Grooves
14111	3 mm.	416	596	38
10875	3 mm.	400	560	38

Siren intermedia from Oakley, S. C.

	2 mm. (most of ovary in post-ovulation condition)			
9193		140	215	32
10872	2.5 mm.	140	198	33
14111	2.5 mm.	132	211	32
14111	2.5 mm.	134	217	32
14111	2.5 mm.	126	204	32

Similarly, in the series of specimens in the National Museum from Upson, Maverick Co., Texas, the *Siren* with large ovarian eggs fall into two size-groups. Moreover, the smaller individuals have fewer costal grooves than those in the large-size group. However, females of the small-size group are larger than the small Georgia *Siren* recorded above as *S. intermedia*. Their costal grooves number rises to thirty-five, which appears to be the average from Imboden specimens. Breeding females from Imboden, however, are not as large as the small form from Texas.

Siren lacertina from Upson, Maverick Co., Texas

U.S.N.M.	Diameter of Ovarian Eggs	Snout to Cloaca	Total Length	No. of Costal Grooves
10861	3.5 mm.	365	550	37
10857	3.0 mm.	430	640	39

Siren intermedia from the same locality

10853	2 mm.	272	382	35
-------	-------	-----	-----	----

Recently hatched *intermedia* from Imboden are stouter and have a more rounded head than young *lacertina* from Gainesville. A similar difference in the shape of the head is frequently observable in adult specimens. However, most specimens that have been preserved in alcohol for a long time fail to show a form difference. Hence the number of costal grooves and the size at sexual maturity are the only diagnostic characters available for use with this material. It is difficult to judge the degree of sexual maturity outside of the breeding season in many specimens, especially in the males. This restricts us to the use of a single character, namely the number of costal grooves, in identifying non-breeding specimens under 350 mm. from snout to cloaca. A study of the large series of *Siren* in the U. S. National Museum, the Museum of Comparative Zoölogy, and The American Museum of Natural History, has revealed that there is a constant average difference between the forms but that some non-breeding specimens having thirty-six coastal grooves may, from the data available, be equally well assigned to either species. We have found no sexually mature female over 365 mm. from snout to cloaca with less than thirty-six costal grooves, and no sexually mature female under 272 mm. snout to vent with more than thirty-six costal grooves. Specimens with thirty-six costal grooves and the gonads not enlarged must for the present be considered indeterminable.

There are two males in the U. S. National Museum from Victoria, Texas, each with thirty-four costal grooves. The first of these (U.S.N.M. No. 7849) is 300 mm. from snout to cloaca and 462 mm. total length. The second (U.S.N.M. No. 78480) would be nearly as long if the tip of the tail had not been cut off. These males are much larger than males of *intermedia* from Georgia or Arkansas. Still, they are not as large as typical *lacertina* from Texas and they have fewer costal grooves. These may be intermediates between *lacertina* and *intermedia* or they may be

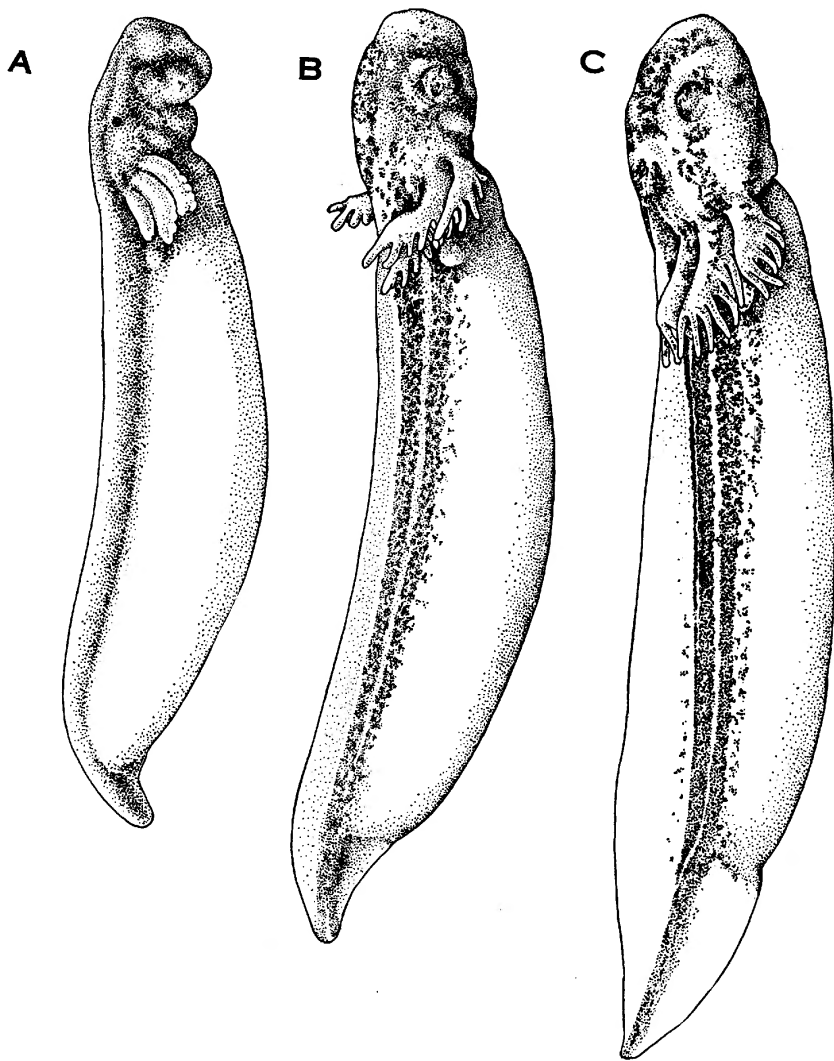


Fig. 2.—The development of *Siren intermedia* LeConte.

A.—Four days before hatching. There is a slight tinge of pigment but no pattern has become established. The dorsal fin has not yet appeared.

B.—At hatching. Forelimb buds are present and the nasal pits form shallow pockets. A thick fold marks the beginning of a dorsal fin. Balancers never appear even as rudiments.

C.—Four days after hatching. The forelimb buds are well developed but no digits have yet differentiated. The color pattern is nearly established.

very old males of the latter species. From the data at hand we cannot settle this problem.

In spite of this uncertainty in regard to some of the Texas material, *intermedia* is usually to be distinguished from *lacertina* by the lower number of costal grooves. In some poorly preserved specimens the costal grooves cannot be counted. Leaving these specimens aside, the remaining ones in the U. S. National Museum, the Museum of Comparative Zoölogy, and The American Museum of Natural History fall into the following modes:

Siren intermedia: one specimen with 31 grooves, eighteen with 32, seven with 33, twelve with 34, thirty-three with 35, and eight with 36.

Siren lacertina: four specimens with 36, twenty-eight with 37, twenty with 38, and six with 39.

Indeterminate: eight specimens with 36. These specimens are not in a breeding state and may be immature *lacertina* or non-breeding *intermedia*.

Our smallest breeding females and all those with only thirty-one and thirty-two costal grooves come from Georgia and South Carolina. Future work may show that this is not identical with the *Siren* of the central states, which have from thirty-four to thirty-six costal grooves and rarely thirty-three. Our largest specimen with thirty-two costal grooves is a male (M.C.Z., No. 140) from Georgetown, S. C. It measures 212 mm. from snout to cloaca and 347 mm. in total length. In size it agrees well with male *intermedia* of the central states. We have examined a series of recently hatched young from Biloxi, Mississippi, and found them identical with the Imboden material, and different from the Florida *lacertina*. Until the life history of the small *Siren* of Georgia and South Carolina has been worked out it seems most conservative to assume there are only two species of *Siren*.

The range of *intermedia* seems to be more extensive than that of *lacertina*, except in the East. We have seen a specimen of *lacertina* taken on the Potomac Flats, District of Columbia, while we have seen no specimen of *intermedia* taken farther north than Guinea Station, Virginia. *Lacertina* occurs in Texas and Florida, but all the specimens from the central states, which we have seen, are *intermedia*. We have seen a sexually immature specimen with thirty-six costal grooves from New Orleans, La., but all the Biloxi, Mississippi, specimens available are *intermedia*. It is possible that *lacertina* does not occur today in the Mississippi Valley, but until more collecting has been done in Alabama and Mississippi we prefer to assume that the range of *lacertina* is not split in two by that of *intermedia*.

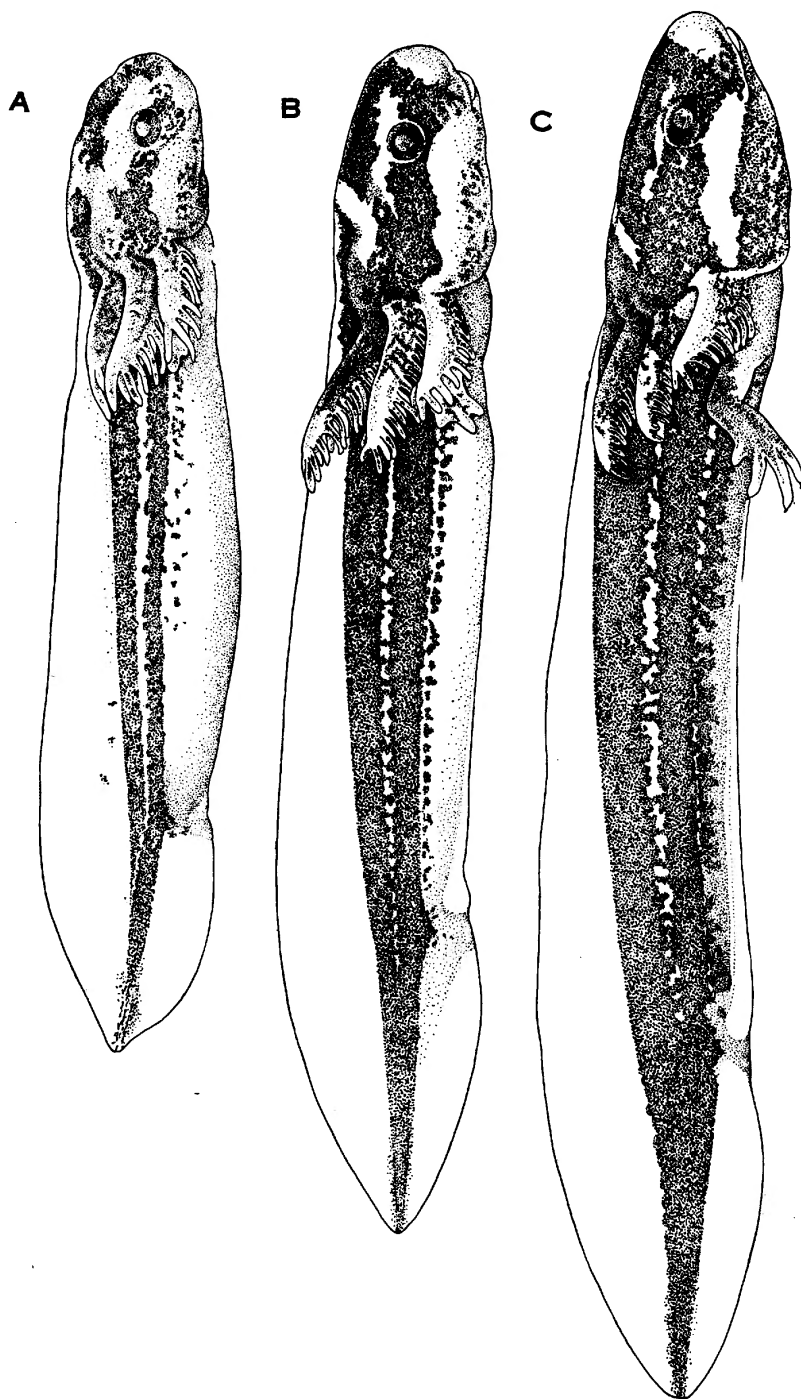


Fig. 3.—Young *Siren intermedia* LeConte.

A.—Ten days after hatching only the first digit has become marked off from the forelimb rudiment.
 B.—Twenty-five days after hatching. Three toes are present on the forelimbs and the fourth is represented by a slight protuberance. The dorsal fin has reached its maximum growth.
 C.—Fifty-one days after hatching. Three of the toes bear horny claws. The dorsal fin is becoming reduced at its extreme anterior end. The yellow stripes on the head have narrowed.

THE EGG-LAYING OF *Siren intermedia*

Our observations on the egg-laying of the Dwarf Siren were made near Imboden, Lawrence County, in the north east corner of Arkansas. The land from three to eight miles south of Imboden is flat and is locally called the "flat woods." It is on the edge of the Arkansas plateau bordering the gulf coastal plain which extends up the Mississippi Valley. The elevation of this region is approximately 800 feet above sea-level. All records of *Siren* from the State are from localities lying within or bordering the northward extension of the coastal plain.

Siren intermedia in the Imboden region appears to be confined to the J. E. Rosa Pond, the Cross Roads Pond, the D. V. Pickett Pond, and the E. Milgrim Pond. These ponds are within a range of one mile and in the spring of the year when heavy rains fall they are connected by slow-flowing streams which join ditches and creeks affording a route by which *Siren* and small fish may gain access to the ponds. There are several other ponds within a radius of two or three miles of the above ponds, but none of these contains *Siren*. Some of these ponds have been well scraped over by collectors, and others have been diligently searched without finding a trace of *Siren*.

The search for the eggs of *Siren* in those ponds frequented by the adults has been carried on since 1926 and extended from early spring to July. During the last week in February, 1931, several sirens measuring 255 to 396 mm. in total length were captured. The largest specimen, which appeared unusually plump, was killed and opened. Its ovaries were distended with eggs ranging from 1.5 to nearly 3 mm. in diameter. There were 139 eggs in the right ovary and 160 in the left, a total of 299. Several of the other sirens captured in February were held in tanks. During the last week in March and the first week in April several eggs were laid on successive nights. None of these eggs was fertile. This may have been due to the fact that no males were present, but in view of some recent work with the egg-laying in *S. lacertina* (Noble and Richards, 1932) courtship may be difficult in *Siren* under laboratory conditions.

On April 8, 1931, a boy collecting in the D. V. Pickett Pond raised a shovel filled with mud to the surface of the water and saw a full-sized *S. intermedia* glide away from the mud. The contents of the shovel was thrown on the ground near the edge of the pond and, as it broke up, a mass of eggs was revealed. The eggs were in a pocket, in the mud, about three inches deep. The mud had been taken from near a snag formed by

a dead bush with the branches broken and piled together. There were about 555 eggs in the lot, a number considerably in excess of the eggs counted in the ovary of the female taken in February. These eggs were very far advanced. They were in approximately the stage shown in figure 2 A.

On April 10, another lot of *Siren* eggs were found at the Cross Roads Pond. The land where the pond is situated lies at such a slope that, by making a ditch on the east side, some of the water could be drained off. After most of the pond had been drained by this method a search for *Siren* eggs began. Many small *Siren* and a few adults were found. Several button-bushes were growing in the pond, and in the mud among the roots of one of these bushes, which had been pulled up and carried out to a dry place, were found 260 eggs in approximately the same stage as those taken on April 8. Some eggs may have been lost in removing the lot and, hence, the actual number of eggs present in this case is uncertain. This observation, however, gave support to our previous conclusion that *S. intermedia* lays its eggs in shallow hollows in the mud at the bottom of ponds. Which parent, if either, makes this "nest" is at present uncertain. The first lot of eggs appeared to have been guarded by an adult, but unfortunately this individual was not caught and hence its sex was not determined.

THE EGG.—The ovarian eggs of the specimen killed February 18, 1931, and preserved in formalin, measure 3 mm. in diameter. One hemisphere is well pigmented, the chocolate tone fading off into the unpigmented hemisphere. The periphery of the pigmented area is darker than the center in only a few eggs. Hence, at this stage the eggs of *S. intermedia* do not agree with the recently laid eggs of *S. lacertina* as described by Noble and Richards (1932). Our recently laid eggs of *intermedia* died before being preserved, but some of the eggs are darker at the periphery of the pigmented area than in the center. We assume this to be typical of the species.

The eggs of *intermedia* laid in the laboratory agree with those of *lacertina* and of *Pseudobranchius* laid under laboratory conditions in that three capsules are present. Further, the outer capsule is slightly opaque as in the case of these other sirenids. The eggs agree mostly with those of *Pseudobranchius* (Noble and Richards, 1932, Fig. 5 A) in that the inner capsule is very thin. The eggs of *S. intermedia* differ from those of the other sirenids in that the middle and especially the outer capsules are very much thinner. An average egg of *S. intermedia* measures 3 mm. in diameter without capsules. The inner capsule is a thin membrane of

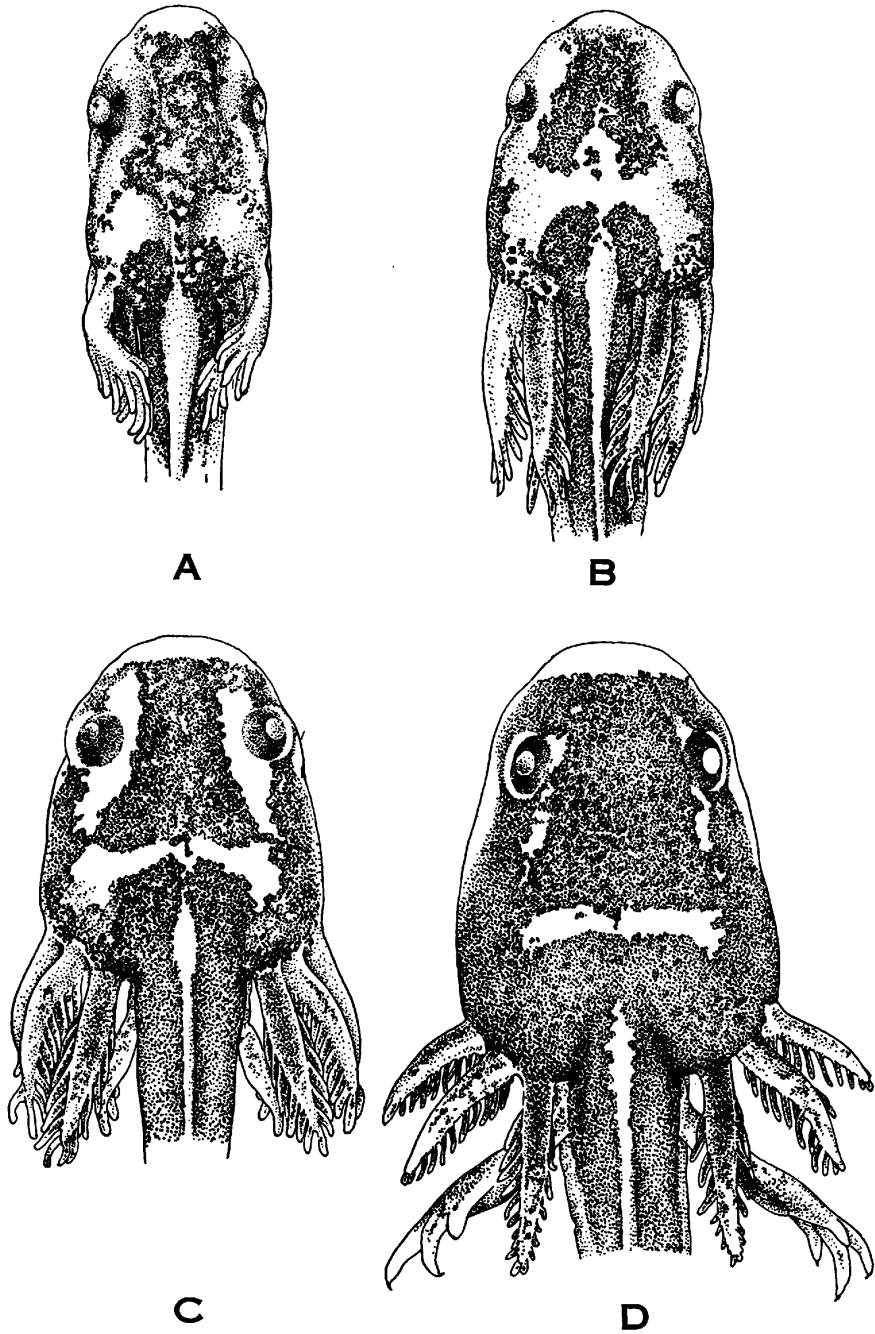


Fig. 4.—Development of the color pattern on the head of *Siren intermedia* LeConte.

- A.—Four days after hatching.
- B.—Ten days after hatching.
- C.—Twenty-five days after hatching.
- D.—Fifty-one days after hatching.

4 mm. in greatest diameter. The space between this capsule and the egg is filled with a fluid, as in other sirenids. The middle capsule is 4.2 mm. in diameter, the outer only 4.4 mm. In striking contrast, the eggs of *S. lacertina* are much larger and have thicker capsules (compare Noble and Richards, 1932, Fig. 5 B). An average egg of *S. lacertina* laid in the laboratory and fixed in formalin several days after laying measures 4 mm. in diameter. Its inner capsule is 5.3 mm. in diameter, its middle capsule 6.2, and its outer capsule 9 mm.

It would be interesting to compare freshly laid and fertile eggs of the two species of *Siren*. The egg-capsules of *S. lacertina* swelled after laying. We have, however, a large series of eggs of *S. intermedia* taken in the field, as described above, and in none of these is the outer capsule swollen beyond the conditions seen in the laboratory eggs. Our conclusions in regard to the egg-capsules of *S. lacertina* rest entirely on observations made on the eggs of a single female. However, we have noticed that the eggs from the ovaries and oviducts of *intermedia* are consistently smaller than fully developed ovarian eggs of *lacertina*. Thus, while further observations on the egg-capsules of these species are much to be desired, there is no doubt that *lacertina* lays larger eggs than *intermedia*. Since we have compared eggs of the two species laid and preserved under comparable conditions, we have concluded that there is also a marked difference in the egg-capsules of the two forms.

The eggs of *intermedia* adhere together in a clump. Some of the eggs from one of the clumps is shown in figure 1. Under laboratory conditions, *lacertina* lays its eggs scattered singly or in small groups. It is possible that in nature the eggs would be laid in a single group. In the laboratory, *intermedia* laid its eggs exactly like *lacertina*, a few each night for an extended period. The outer capsules of these eggs were very sticky and adhered to one another, to the sides of the tanks, and to the tail-fins of the adults.

The eggs of *intermedia*, immediately before hatching, measure from 5.5 to 6.5 mm. in diameter including all the capsules. They adhere closely to one another and there are no cords or pedicels to the individual eggs. The outer capsule is extremely thin and membranous. As shown in figure 1, small sticks and other debris adhere to it.

DEVELOPMENT.—Some of the eggs were preserved the day collected. The earliest stage represented in either lot is shown in figure 2 A. The embryo is already well developed. The three gill-rudiments have begun to develop secondary processes. The forelimbs are indicated by buds. The remarkable feature of this embryo is its slim form. It is 10.5 mm. long by only 2.1 mm. high.

As shown in figure 2 A, the stomadæum at this early stage is well marked. The mandibular arches are well formed and meet in the mid-line, but the point of symphysis is broadly notched anteriorly. The nasal pits are already present as shallow pockets. The optic vesicles are distinct but not well marked off from a swelling on each side which appears to be the placode of the trigeminal nerve. The vent has arisen at this stage as a shallow pit at the base of a very short tail.

At the time of hatching, four days later, several important changes have occurred (Fig. 2 B). Perhaps the most distinctive is a dorsal ridge which is destined to become a conspicuous dorsal fin. This structure has not been reported in the young *S. lacertina*, probably because no sufficiently early stages of that species have been collected. Dorsal fins are characteristic in general of salamander larvæ living in ponds (Noble 1927), but another feature common to pond larvæ, the balancer, is not present at this stage and never appears.

At the time of hatching, a color pattern is already present. At the stage described above, only a few pale melanophores are visible on the dorsum, but at hatching a dark stripe extends along either side of the back and is divided by the pigmentless crest which is to become the dorsal fin. On either side this stripe is divided by a narrow pigmentless line. As shown in figure 4 A, some pigment has appeared on the top of the head and this is destined to form the pattern which we find distinguishes *intermedia* from *lacertina*.

At hatching, both the buccal and cloacal depressions are shallower than in the preceding stage. The nasal pits and eyes are better formed and the gills now have many branches. During the next fifty-five days, the young *Siren* gradually assumes the head-form it is to retain for the remainder of its life. As shown in figure 2 C, the nasal pits arise directly under the anterior margin of the eye. In the change of head-form they are carried out with the developing snout. On the tenth day after hatching the mouth is represented by a crescentic groove anterior to which is a shallow pocket which may represent a hypophysial depression. The mouth becomes perforate between the twelfth and fourteenth days. The cloaca may open by the ninth day. Labial folds appear about the time the mouth opens and are well established by the sixteenth day. The growth of the forelimb is shown in the figures. By fifty-five days after hatching, the forelimbs are fully formed and all but the fourth digit are covered with horny claws. The most distinctive feature of these young salamanders is their absurdly short tails. The long body of *Siren*, one of its most characteristic features, is established very early and, as

if to compensate for this attenuation of body, the tail remains short during this period, while in other salamanders it is rapidly growing in length.

In figures 2 C, 3 and 4, we have represented four stages in the growth of the color pattern. In addition to the narrow white streak down either side of the body there appears another thin white line along either side of the belly. In some specimens there is still a third streak of white on either side at the base of the dorsal fin, barely within the pigmented area. In view of the relation of pigmentless areas to the lateral-line organs in various other salamanders, it would appear probable that these three streaks represent the course of the lateral-line organs. Some lateral-line organs may be seen within the pigmentless areas, but the full distribution of these organs cannot be traced in our formalin preserved material without sectioning.

The pigmentless areas on the head early become invaded by lipophores which give these areas a bright yellow tone. In some specimens the yellow on the gills may be orange or reddish. As shown in figure 4, these yellow areas become gradually narrowed, and nine months after hatching the transverse bar on the occiput and the two horizontal streaks over the eyes have practically disappeared, leaving only the broad band of yellow on the snout to distinguish these larvæ at a glance from those of *lacertina*.

Another gradual change which begins approximately two months after hatching is the reduction of the dorsal fin. At seven months the reduction is far advanced, and at nine months the salamanders have the same reduction seen in the adults. These observations were made on young reared in the laboratory, and it is possible the reduction of dorsal fin proceeds more quickly in nature. We have seen larvæ only 46 mm. in total length, collected near Imboden on June 20, that showed a complete reduction of the dorsal fin.

We have not been very successful in correlating size groups secured in the field with age groups worked out in the laboratory. On May 18, 1929, a young *Siren* only 24.5 mm. in total length was captured at Milgrim Pond. Several others, 50 to 75 mm. in length, were taken June 11, 1927, from the same pond. At the same time many *Siren*, 150 to 250 mm. in length and averaging 200 mm., were secured. It might be assumed from these data that the two last size groups represent young of two succeeding years, and that the 24.5 mm. salamander belonged to a group which would reach 50 mm. in length by the middle of June. But the young we have raised in the laboratory did not grow this fast.

We have raised two lots of *intermedia*: one in New York and the other in Imboden. The first was kept in spring water and fed enchytræids; the second lot was reared in half-gallon fruit jars supplied with diatoms. At the end of fifty-five days average specimens from both lots were 22 mm. in total length. This is the more surprising in that hatching occurred in the laboratory from April 16 to April 26. It would indicate that the young during this period depended to a large extent on their yolk.

Six of the young *Siren* have lived nine months in New York, apparently feeding on the enchytræids. On November 4 they measured 38, 41.5, 42, 53, 58, and 61 mm. in total length respectively. On January 26 they measured 45, 48.5, 51, 60.5, 61, and 69. This would appear to indicate that the 50 to 75 mm. *Siren* captured in June were over a year old, and not young of that year. It will be noticed, however, that some *Siren* grew nearly twice as fast as others and it is not unlikely that under natural conditions they grow faster than in the laboratory. It is also possible that *Siren* has a more extended breeding season than we have been able to determine. Until more data are available it is impossible to determine the age of *intermedia* at sexual maturity.

HABITS OF THE ADULT

S. intermedia appears to be entirely aquatic for, in spite of extensive collecting during many years about Imboden, none has ever been found on land. In the case of *lacertina* there are several records of this species being found on land. In one case observed by Noble the salamander was under a stone in a hollow which previously may have been filled by rain-water.

Although *Siren* was one of the earliest salamanders described from America and was well known to the early American naturalists, there is still considerable uncertainty in regard to its food. LeConte (1824, p. 53) remarks in regard to the stomach of *lacertina*: "I have never found that organ to contain anything but mud." Dunn (1924) called attention to the large quantity of vegetable matter in the stomachs of this species. We have noticed that adult *intermedia* for several days after their capture expel great quantities of partly disintegrated *Spirogyra* from their intestines. This is accompanied by pieces of the exoskeleton of crayfish and the shells of bivalves. Dr. W. Van Name has kindly identified one of these molluscs and found it to be *Sphærium occidentale*. In the laboratory we have found that *lacertina* will devour *Spirogyra* with their earthworms. The quantity of algæ expelled by *intermedia*

far exceeds the residue of animal food. It is therefore certain that *intermedia* normally devours large quantities of algæ. At the present time we have not been able to establish that either species of *Siren* will eat algæ alone, unaccompanied by animal food.

Much of the collecting for *intermedia* was done at night, with lights. Between 10 P.M. and morning, adults are often seen, but at the first streak of dawn they disappear. If they are disturbed from the mass of thick water-weed in which they hide they will swim swiftly to another retreat of darkness. Relatively few are seen before 10 P.M. in the evening. According to our observations in Florida, *lacertina* has similar nocturnal habits. However, we have seen many early in the evening. A *lacertina*, disturbed during the day, will make off through a dense growth of water-weed with a very surprising speed.

ACKNOWLEDGMENTS

We are indebted to Dr. Thomas Barbour for the opportunity of studying the collection of *Siren* in the Museum of Comparative Zoölogy. We wish to acknowledge our indebtedness to Dr. L. Stejneger for the loan of a series of *Siren* preserved in the National Museum collection.

SUMMARY

1.—There are two species of *Siren* widely distributed throughout United States. These are distinguished by size at ovulation, the average number of costal grooves, the size of the eggs, thickness of the egg-capsules, the coloration of the young for nine months after hatching, and the body proportions for a more extended period.

2.—LeConte did not distinguish between these species when describing *Siren intermedia*, but we reinstate this name usually placed in the synonymy of *lacertina* and restrict it to the smaller species described here.

3.—The recently hatched young of *S. intermedia* is remarkable for its long body, short tail, and broad dorsal fin extending the full length of the back.

4.—Changes taking place in the head and forelimbs during the first fifty-five days after hatching are described. No balancer ever appears.

5.—Reduction of the dorsal fin begins about two months after hatching but is not complete in some specimens until nine months.

6.—Both species of *Siren* are nocturnal. The adult *intermedia* devours quantities of *Spirogyra* and possibly other algæ with its animal food which consists of crayfish and molluscs.

LITERATURE CITED

- COPE, E. D. 1889. 'The Batrachia of North America.' Bull. U. S. N. M., No. 34.
DUNN, E. R. 1924. '*Siren*, a Herbivorous Salamander.' Science (N.S.), LIX, p. 145.
ELLIS, JOHN. 1766. 'An Account of Amphibious Bipes.' Philos. Trans. Roy. Soc., London, LVI, pp. 189-192.

- LECONTE, JOHN. 1824. 'Description of a New Species of *Siren*, with some Observations of Animals of a Similar Nature.' Ann. Lyceum Nat. Hist., N. Y., I, pp. 52-58.
1826. 'Description of a New Species of *Siren*.' Ann. Lyceum Nat. Hist., N. Y. pp. 133-134.
- LINNÉ, C. 1767. 'Systema Naturæ.' 13th Ed.
- NOBLE, G. K. 1924. 'The "Retrograde Metamorphosis" of Sirenidæ; Experiments on the Functional Activity of the Thyroid of the Perenni-branches.' Anat. Rec. XXIX, p. 100.
1927. 'The Value of Life-history Data in the Study of the Evolution of the Amphibia.' Ann. N. Y. Acad. Sci., XXX, pp. 31-128.
- NOBLE, G. K., AND RICHARDS, L. B. 1932. 'Experiments on the Egg-laying of Salamanders.' Amer. Mus. Novitates, No. 513, pp. 1-25.

